Diagnosis of Brain Tumors

A Comparison of Photoscanning and Neuroradiological Techniques

KENNETH R. MC CORMACK, M.D., AND THOMAS H. NEWTON, M.D.
San Francisco

■ *Results of radioisotope photoscans and diagnostic neuroradiological procedures performed in 167 patients with suspected brain tumors led to the conclusion that correct identification of the intracranial process can be obtained in a high proportion of cases by the proper selection of available diagnostic techniques. The radioisotope photoscan had a relative diagnostic accuracy nearly equal to that of the neuroradiological techniques. The accuracy, taken with the relative ease and safety of the method, make it an ideal screening procedure in cases in which intracranial pathologic change is suspected.*

CEREBRAL ANGIOGRAPHY, pneumoencephalography and ventriculography have been used for many years for further investigation when brain tumor is suspected clinically. More recently, various radioisotopes have been utilized in the diagnosis and in determining the location of intracranial lesions.[2,3,9,12,15] The isotope procedures have been particularly stressed as screening procedures.[7,13,16] Various isotope techniques have been employed successfully in localizing brain tumors.*

In an attempt to assess the value of radioisotopic brain scans, the results of brain scanning were compared with results of various neuroradiological procedures. The records of 167 patients who had isotopic brain scans and either cerebral angiography or encephalography, were reviewed. These patients were seen at the University of California Hospitals, San Francisco, in the period July 1962 through March 1964. In each case the original interpretations of these various studies were compared with each other and with the final diagnosis.

The selection of the initial diagnostic roentgenologic procedure for each patient was determined by the clinical information. Cerebral arteriography was performed in 48 patients, encephalography in 38 and a combination of angiography and air-contrast study in 81.

An intravenous dosage of ^{203}Hg-chlormerodrin, 8 to 10 microcuries per kilogram of body weight, was given in all but two cases. The scanning procedure, utilizing a Picker Magna Scanner and photoscanning, was usually started four hours after intravenous administration of the radioisotope. A lateral and an anterior or posterior scan was obtained in each study. Additional scans were obtained in selected cases.

Results

The results of the various diagnostic procedures were interpreted as demonstrating the presence or absence of, or as being suggestive of, findings consistent with a brain tumor. Histologic proof was

From the Sections of Nuclear Medicine and Diagnostic Radiology, University of California School of Medicine, San Francisco.
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available in 85 patients. In the other 82 patients no pathologic material was available and the diagnosis at time of discharge was accepted and utilized in the tabulation. Any difference between the interpretation of the angiographic, air-contrast and radioisotopic procedures was considered a disagreement. A difference in localization of tumor site or in the number of recognized lesions was also considered an instance of disagreement. In this analysis, complete agreement among the various techniques was found in only 98 (59 per cent) of the 167 cases.

Patients in this series were separated into "nontumor" and "tumor" groups on the basis of the final diagnosis.

Nontumor groups. Cerebral abnormality other than intracranial tumor was the final diagnosis in 86 patients. In 61 of these patients, no sign of tumor was found by any technique. Included were 15 patients with a final diagnosis of cerebrovascular insufficiency. In eight cases, at least one of the roentgenologic results suggested a space-occupying lesion, but the scans were negative. The roentgen studies in an additional eight patients were negative, but the photoscan, which suggested increased radioactivity in one view, was not confirmed in the accompanying view. In three patients a benign cystic lesion was found. In one of the three an arachnoid cyst of the inferior frontal lobe was diagnosed on carotid arteriography as a mass in the temporal lobe. It was not identified on the pneumoencephalogram or on the photoscan. In the second patient a congenital cyst of the occipital lobe was diagnosed as a space-occupying lesion on both pneumoencephalogram and carotid arteriogram. This lesion was not demonstrated on the photoscan. A mass in the cerebellopontine angle observed at encephalography of the third patient proved to be an extradural cyst, possibly a cholesteatoma. The photoscan of this patient, in the lateral projection only, suggested localization in the anterior cerebellar region.

In three patients with an angiographic diagnosis of intracranial hemorrhage or cerebrovascular occlusion, the photoscans showed concentration of radioactivity in the area of the vascular accident.

In another patient, surgically proved basilar arachnoiditis had been interpreted at ventriculography as a suprasellar tumor. The results of bilateral carotid arteriograms and photoscans were normal.

An abscess of the frontal lobe was correctly localized by both arteriography and photoscan.

Bilateral carotid arteriograms of an additional patient were reported as showing no abnormalities, but a faintly positive localization was seen in the parasagittal region of both views of the photoscan. The diagnosis at the time of discharge was diffuse disease of the central nervous system, possibly vascular in origin. The photoscan in this instance was interpreted as showing a tumor and must be considered as a false positive interpretation.

Tumor cases. A primary or metastatic tumor of the brain was diagnosed in 81 of the 167 patients. Histologic proof was available in 65 of the 81. The various types of tumor found and the number of cases in which the presence of tumor was shown by each procedure are shown in Table 1. A discussion of the agreement or disagreement among

TABLE 1.—*Positive Identification of Brain Tumors by Photoscanning and Neuroradiological Techniques*

Tumor type	Number of cases	Angiography		Pneumoencephalography		Isotope photoscan		Complete agreement among procedures	
		Number correct	Number studied	Number correct	Number studied	Number correct	Number studied		
Astrocytoma	19	16	16	15	16	9	19	8	19
Glioma and glioblastoma	14	10	14	4	5	14	14	10	14
Oligodendroglioma	3	2	2	1	1	2	3	2	3
Medulloblastoma	1	....	....	1	1	0	1	0	1
Ependymomas	2	....	....	2	2	2	2	2	2
Meningioma	12	9	11	5	6	11	12	9	12
Meningeal sarcoma	2	0	1	1	2	0	2	0	2
Cerebellopontine angle	3	0	0	2	3	0	3	0	3
Pituitary tumors	3	2	2	2	3	3	3	2	3
Metastatic tumors	14	9	14	7	8	12	14	5	14
Inoperable tumors	4	4	4	4	4	2	4	2	4
Tumor suspect	1	0	1	1	1	0	1	0	1
Died without necropsy	3	2	3	2	3	1	3	1	3
TOTAL	81	54 (79 per cent)	68	47 (85 per cent)	55	56 (69 per cent)	81	41	81

the diagnostic procedures for each tumor type follows:

Astrocytoma. Complete agreement in the diagnosis was obtained by means of roentgen and radioisotope procedures in eight of 19 tumors in this category. In one patient, a tumor that was suspected on a technically unsatisfactory pneumoencephalogram as being in the right frontal area was verified by positive photoscan. In four patients, photoscans were suggestive of but did not positively identify tumors that had been diagnosed correctly by pneumoencephalography or arteriography. Well differentiated frontal lobe astrocytomas diagnosed roentgenologically in three patients were not identified by the photoscan. Identification of a fibrillary astrocytoma of the frontal lobe in another patient was positive on the angiogram but not confirmed by pneumoencephalogram or photoscan.

In one patient a grade III astrocytoma of the thalamus, correctly identified by both pneumographic and angiographic studies, was not identified by the photoscan. A large calcified subependymal astrocytoma in the third ventricle was diagnosed by angiography and pneumoencephalography but on the photoscan the site was not positively localized.

Glioma and Glioblastomas. All 14 lesions in this category were correctly localized by photoscan. Arteriographic and air-study, however, were correct in only 10 instances. One lesion was missed at arteriography because of technical problems. In another patient, a cystic glioma of the parietal lobe was suspected, but not definitely diagnosed, on a carotid arteriogram. Angiographic differentiation between postoperative changes and recurrence was not possible in one patient with a recurrent lesion in the temporal lobe. Carotid arteriograms repeated three months later showed a definite recurrence of tumor. Arteriograms and pneumoencephalograms were considered normal in a patient with a lesion of the frontal lobe that was distinctly positive on the photoscan. Roentgen studies repeated one month later, however, showed the presence of a frontal lobe glioblastoma.

Oligodendrogliomas. Postoperative recurrences were correctly identified by arteriography and photoscan in one patient and by pneumoencephalogram and photoscan in another. In a third patient, a partly calcified frontal lobe tumor was positively identified by arteriogram but only suspected on the photoscan.

Medulloblastoma. A medulloblastoma filling the fourth ventricle was correctly diagnosed at ventriculography, but was not identified by a photoscan.

Ependymoma. The two ependymomas in this series were correctly identified by both ventriculography and photoscan.

Meningiomas. The methods were in complete agreement as to localization in nine of the 12 cases of meningiomas. A recurrent meningothelial meningioma of the tuberculum sellae was not identified by the photoscan technique, but was identified by both angiographic and pneumographic studies. Recurrence of a large lesion of the occipital lobe in another patient was suggested by angiographic studies and demonstrated by scan. A sphenoid-wing meningioma identified subsequently by photoscan had been suspected by angiographic studies, but not identified on pneumoencephalography.

Meningeal sarcoma. In one patient, diffuse meningeal sarcomatosis was suspected on the basis of pneumoencephalography but was not noted on photoscan. A second patient had a parasagittal subdural lymphosarcoma identified on pneumoencephalography but not seen on angiogram and only suspected on photoscan.

Cerebellopontine angle tumors. Incomplete pneumoencephalograms and a photoscan did not identify an acoustic neurinoma in one patient. Plain roentgenograms of the skull, however, showed erosion of the internal auditory meatus. In two additional patients with acoustic neurinoma the lesions were identified by pneumoencephalography, but photoscans were negative in one and only suggestive in the other.

Pituitary tumors. One recurrent suprasellar extension of a chromophobe adenoma and one craniopharyngioma were correctly identified by all three techniques. In another case in which recurrence was suspected on pneumoencephalography but not confirmed by photoscan, only scar tissue was found on surgical operation.

Metastatic tumors. Biopsy of the primary tumor was available in each of the 14 instances; in only six, however, was the suspected metastatic cerebral focus histologically confirmed. Complete agreement as to the site and number of metastatic lesions was noted in five instances. In two patients, multiple lesions were reported on photoscan, but

only single lesions were observed at angiography. In another patient, only one lesion was observed on the scan, whereas two were found on angiography. Single metastatic lesions in three other patients, positively identified by photoscan, were only suggested at angiography; a pneumoencephalogram, however, confirmed the diagnosis in one of these patients. One metastatic tumor was identified on photoscan but not on angiograms. In two patients, a single metastatic lesion was identified by pneumoencephalography and arteriography, but on photoscan was only suspected in one patient and not observed at all in the other.

Inoperable tumors. In four patients, histologic confirmation of suspected tumor could not be obtained, as the location of the tumor made biopsy excessively hazardous. A mass in the lateral ventricle in one patient and a cystic tumor of the thalamus in another were positively identified by all three techniques. A probable pinealoma and a tumor anterior to the pons, missed by photoscan, were diagnosed by angiography and pneumoencephalography.

Suspected tumor. One patient with a suspected brain tumor was included in the series. Identification was positive in the parasagittal area on pneumoencephalography, suggestive on photoscan and not confirmed on arteriograms. The patient died three months later in another hospital. The death certificate stated that an uncal herniation secondary to glioblastoma multiforme caused death.

Postmortem confirmation was not obtained in three patients in whom brain tumor was suspected.

Discussion

A comparison of the accuracy of pneumoencephalography, arteriography and photoscan techniques in the diagnosis and localization of brain tumors is difficult. Our series was limited to patients who had had both a brain photoscan and an arteriogram or encephalogram. The use of isotopic techniques in addition to the standard neuroradiologic procedures was often determined by the need for additional information in doubtful or difficult diagnostic problems. The selection of patients in this series is, therefore, a necessarily biased one, and the true accuracy of the various available techniques is difficult to assess.

Arteriographic diagnosis was accurate in 54 of 68 tumors in this series (79 per cent). In an additional six patients (9 per cent), the correct diagnosis was suspected on angiography and was confirmed by either encephalography or photoscan.

Pneumoencephalography or ventriculography provided a correct diagnosis in 47 of 55 cases of intracranial tumor (85 per cent). In three additional patients, tumors were suspected on pneumoencephalography and the diagnosis was confirmed by the other techniques, raising the accuracy to 91 per cent.

Of the 81 patients with intracranial tumors, the photoscan was reported as positive in 56 (69 per cent). Localization which had been suspected in both views in an additional nine patients was confirmed by the other procedures, making the accuracy of the combined technique 80 per cent.

Only one of the tumors in this series, an acoustic neurinoma, was missed by pneumoencephalographic examination and isotope photoscan. False positive localization was reported in one pneumoencephalographic study and in one isotope photoscan.

Positive localization with a photoscan technique depends on a breakdown in the normal blood-brain barrier. Any condition that alters this normal barrier can produce the evidence for a positive localization.[4-6,11,18] Localization in this series was positive, therefore, not only in tumors, but also in acute abscess, vascular occlusion and recent intracerebral hemorrhage. The radioactivity in the cases of cerebral vascular accident was not, however, as concentrated as that generally noted in localization of primary and metastatic tumors.

Difficulties in localizing cystic slow-growing tumors by using isotope techniques have been reported.[8,19] Tumors of this type, present in nine of the cases in the present series, were not positively identified by photoscan. Difficulties have also been reported in the isotope localization of tumors near the midline, in the posterior fossa and adjacent to the base of the skull where vascular background activity is high.[4,10,14,19] Ten tumors not localized by photoscan techniques in the present series were at these adverse locations.

The accuracy of results of radioisotope techniques in relation to tumor type has been reported previously.[11,13,14,18,19] Similar results were obtained in this series. On several occasions the distinctly positive localization prompted surgical intervention when results of roentgen procedures were only suggestive or were negative. Distinct localization on isotope photoscan has also been used to direct the placement of ports for radiation therapy in in-

stances of known tumor recurrence, thus avoiding the need for surgical reexploration.

Department of Radiology, U.C. Medical Center, San Francisco, California 94122.

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